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(54) **AUTOMATIC GAIN CONTROL CIRCUIT IN VIDEO SIGNAL PROCESSING DEVICE**

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348/678, 752, 571
See application file for complete search history.

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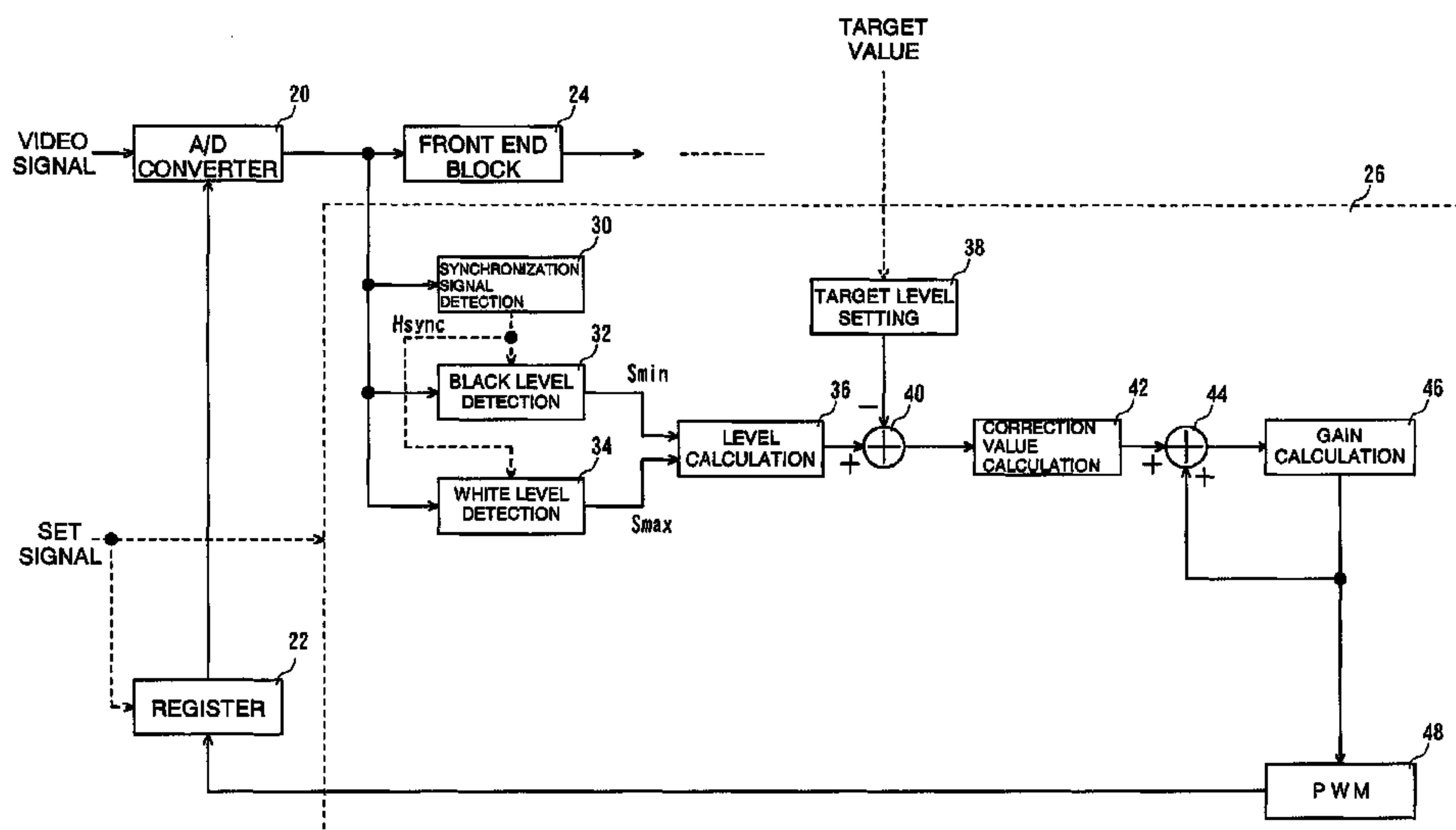
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(57) **ABSTRACT**

In an automatic gain control circuit comprising a black level
detecting unit which detects a black level from a video signal,
a white level detecting unit which detects a white level from
the video signal, and an analog-to-digital converter which
adjusts a dynamic range of the video signal based on a dif-
ference value between the black level and the white level, a
video signal for adjustment including a black level which
indicates a minimum brightness of a video image and a white
level which indicates a maximum brightness of the video
image is input and the dynamic range is adjusted.

2 Claims, 6 Drawing Sheets



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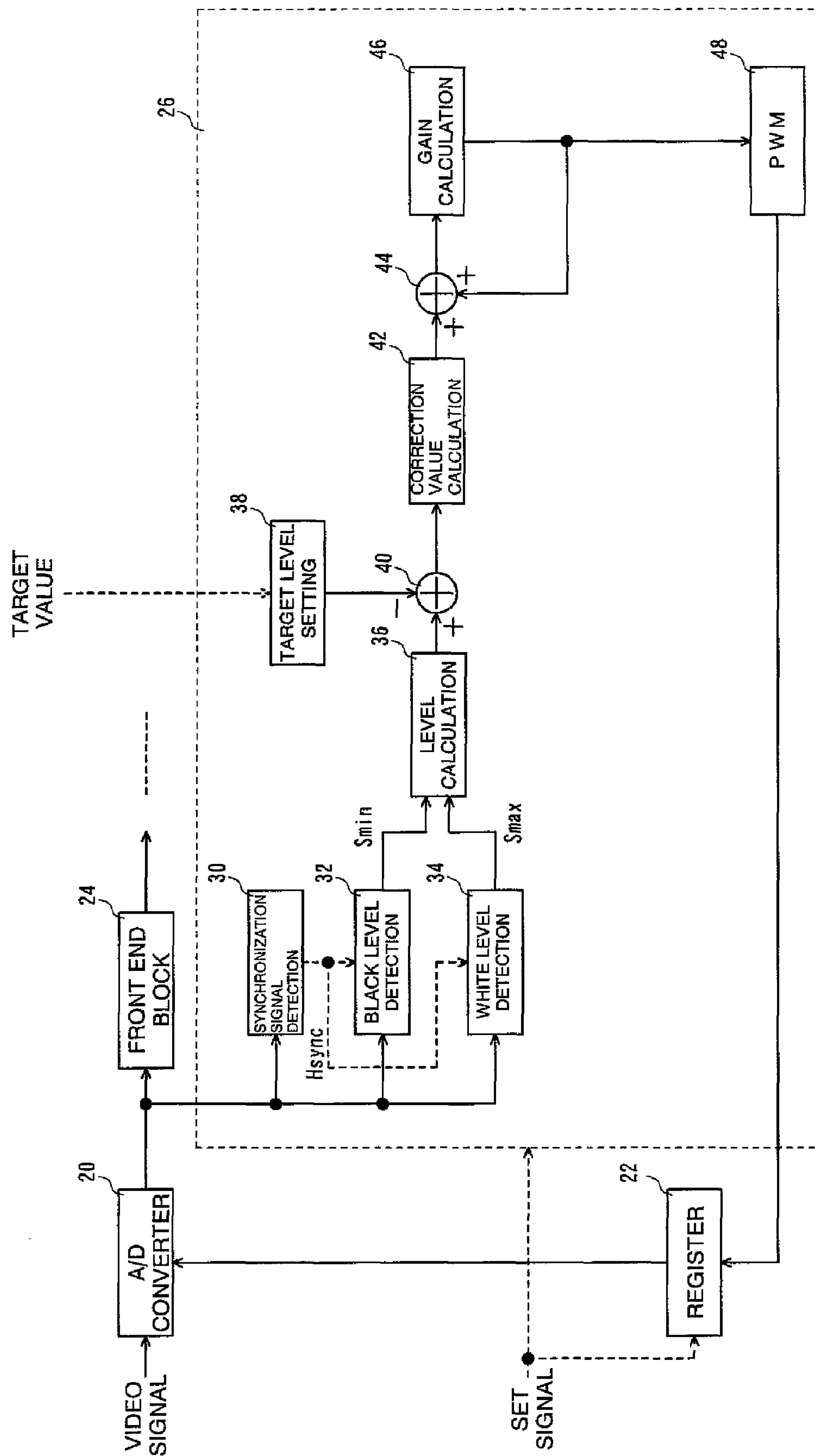
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FIG. 1

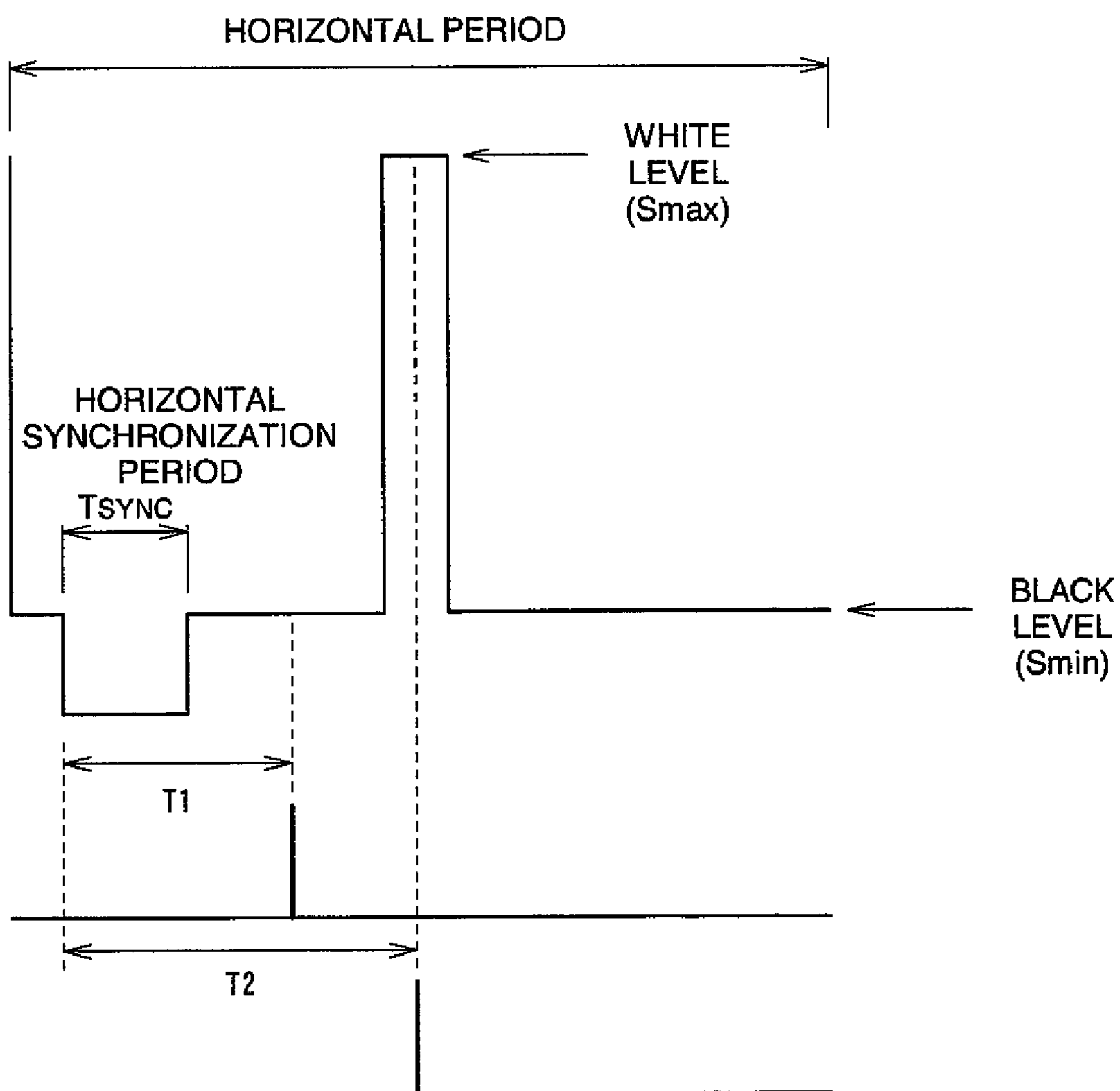


FIG. 2

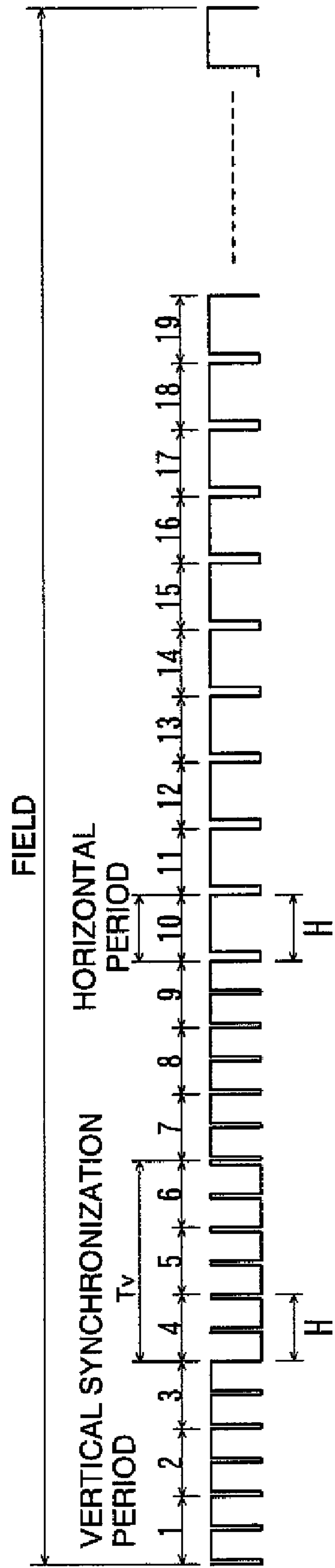


FIG. 3

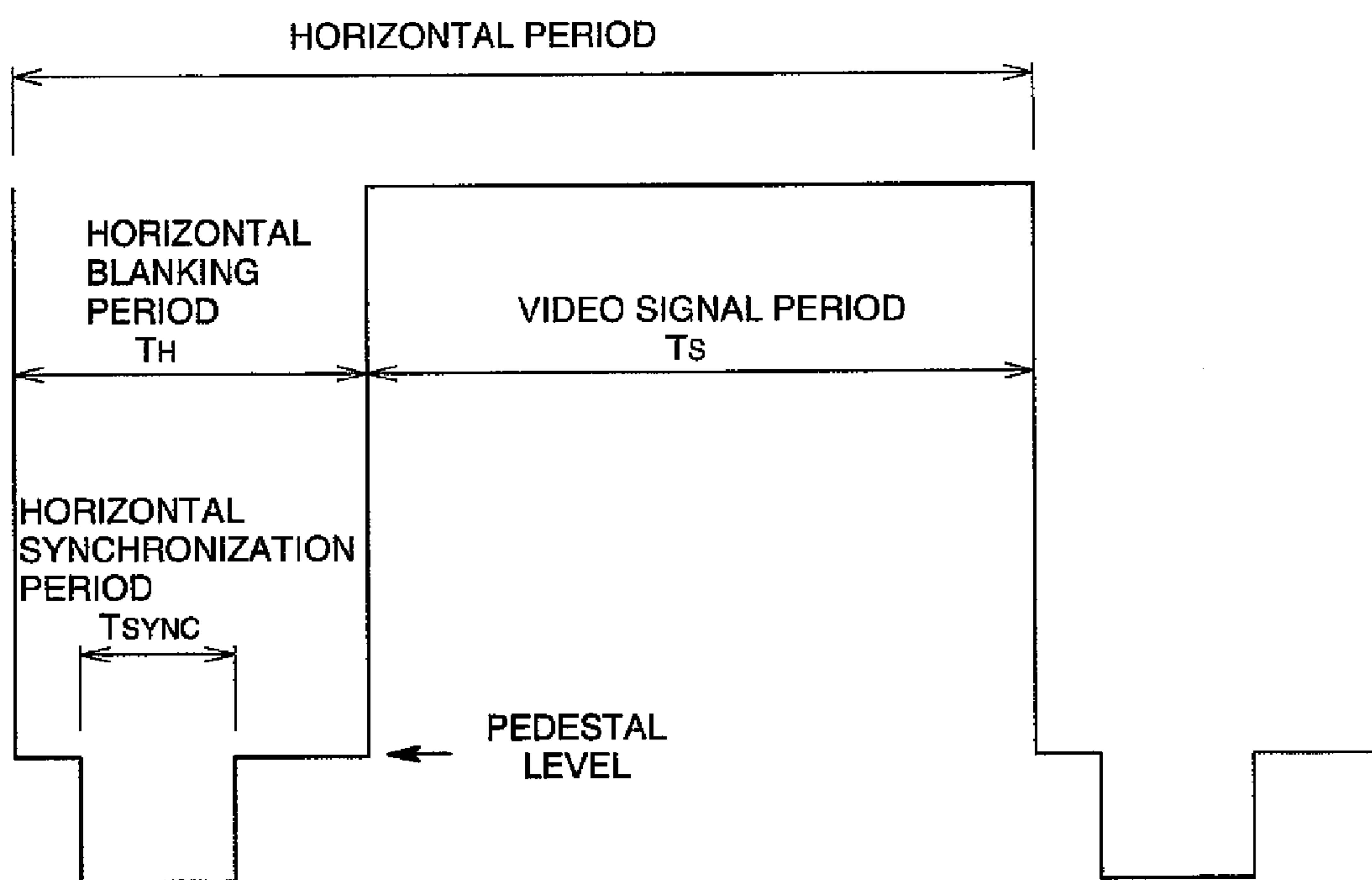
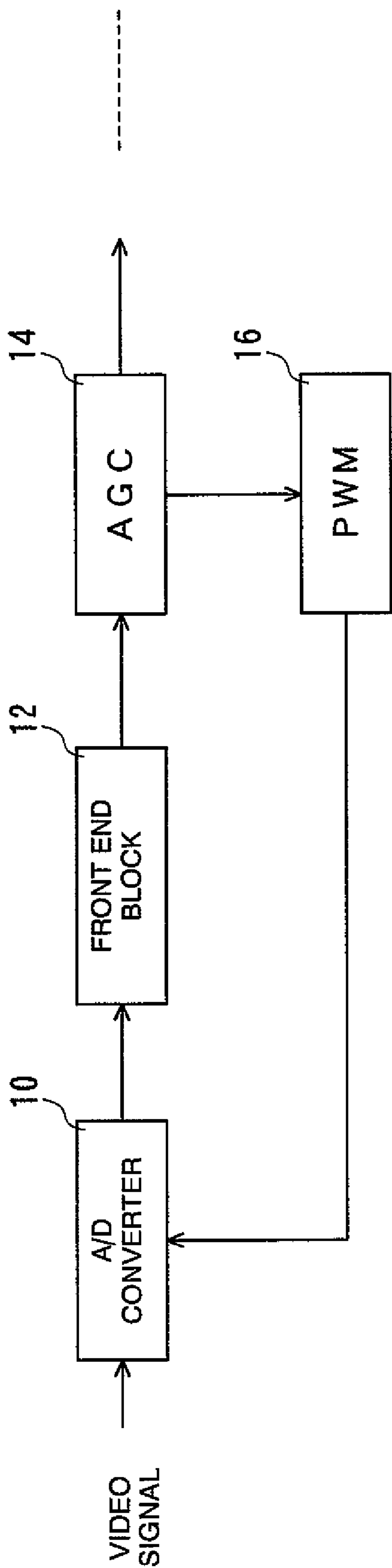
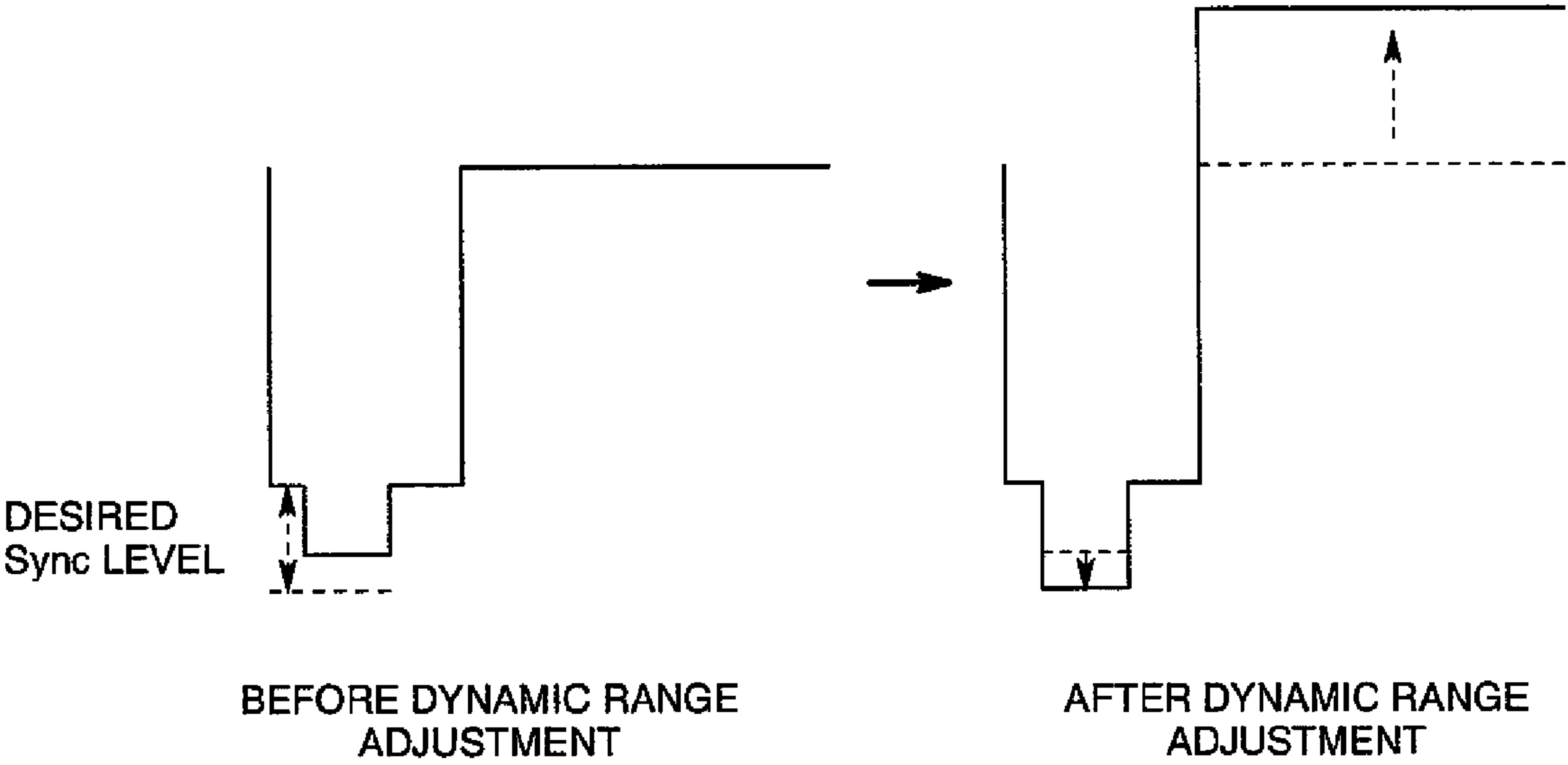


FIG. 4

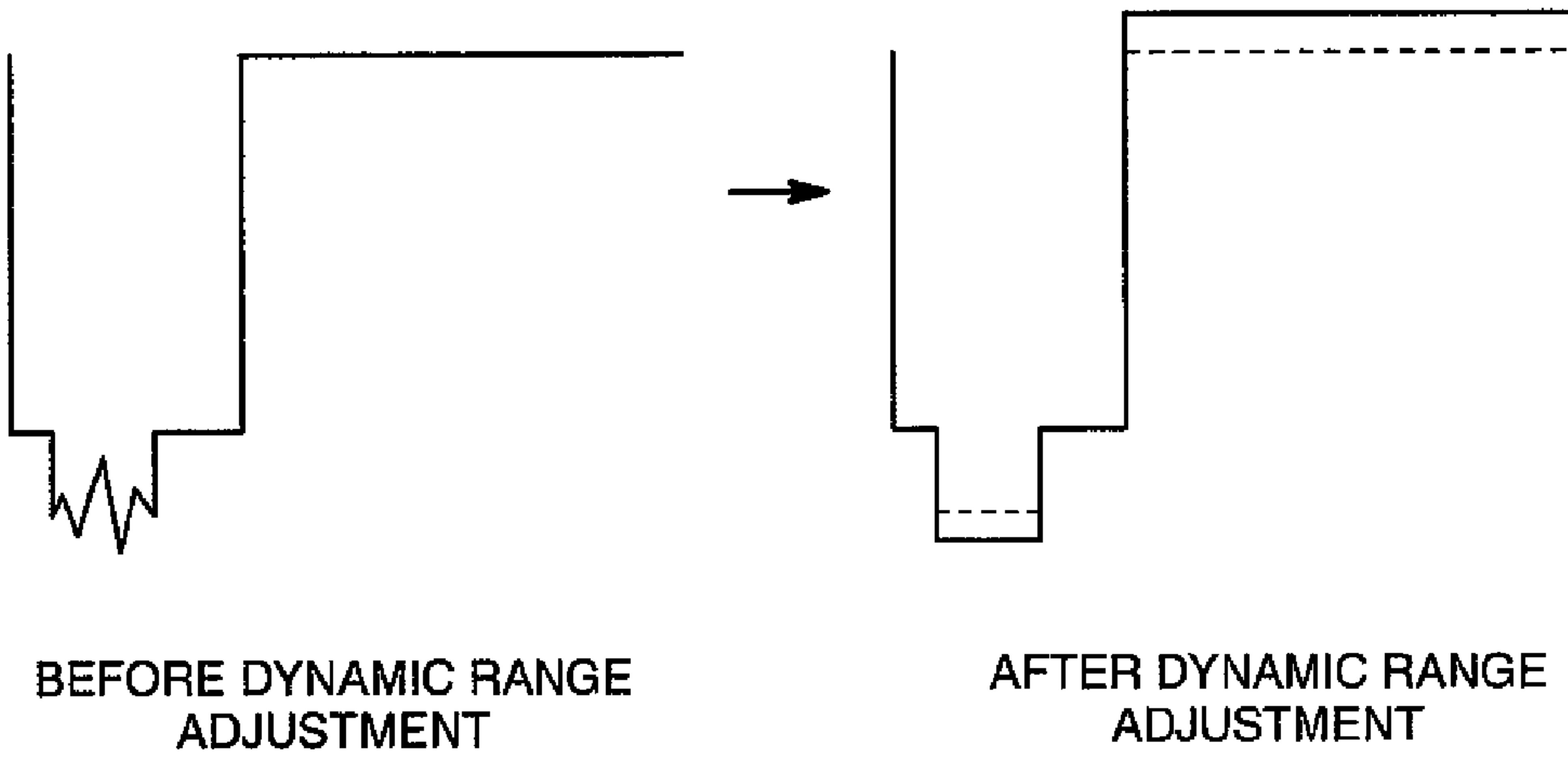


100

Related Art
FIG. 5



Related Art
FIG. 6A



Related Art
FIG. 6B

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AUTOMATIC GAIN CONTROL CIRCUIT IN
VIDEO SIGNAL PROCESSING DEVICECROSS-REFERENCE TO RELATED
APPLICATIONS

The disclosure of Japanese Patent Application No. 2007-265255 including specification, claims, drawings, and abstract is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an automatic gain control circuit used in processing of a video signal.

2. Description of the Related Art

In a video signal processing device which displays a video signal of NTSC system (composite video signal) as a video image, there is used an automatic gain control circuit which amplifies a video signal to a certain level in an analog-to-digital converter in order to maintain a dynamic range of the brightness of the video image approximately constant.

As shown in FIGS. 3 and 4, a video signal S_{IN} of one field includes a vertical synchronization period T_V , a horizontal blanking period T_H , and a video signal period T_S . The video signal S_{IN} of one horizontal line includes a horizontal blanking period T_H , a color burst period T_C , and an effective video signal period T_I . In FIGS. 3 and 4, in order to simplify explanation, the video signal S_{IN} is displayed with the ratios among periods of the video signal S_{IN} differing from those of the actual video signal S_{IN} .

As shown in FIG. 5, an automatic gain control circuit 100 of related art comprises an analog-to-digital converter (A/D converter) 10, a front end block 12, an automatic gain control circuit (AGC circuit) 14, and a pulse width modulation circuit (PWM circuit) 16. A video signal which is input to the A/D converter 10 is converted from an analog signal to a digital signal. In this process, according to a width of a pulse which is input from the PWM circuit 16, the dynamic range of the digital conversion is adjusted. The digitized video signal is output to the front end block 12. At the front end block 12, a pre-process for the video signal is executed. The pre-process includes processes such as, for example, filtering and Γ correction. The video signal passing through the front end block 12 is input to the AGC circuit 14.

The AGC circuit 14 extracts a signal level of the horizontal blanking period T_H of the video signal and outputs the signal level to the PWM circuit 16. The PWM circuit 16 generates a pulse signal having a pulse width which is proportional to the input signal level, and outputs the pulse signal to the R/D converter 10. As shown in FIG. 6A, the A/D converter 10 adjusts the dynamic range according to the pulse width of the pulse signal and digitizes the video signal. In this manner, the level of the video signal is fed back to the A/D converter 10, and the dynamic range of the video signal is maintained approximately constant. Such adjustment of the automatic gain control is executed in an initial adjustment process performed after a manufacturing process of the video signal processing device.

However, as shown in FIG. 6B, the signal level in the horizontal blanking period T_H of the video signal may vary due to an influence of noise or the like. In this case, if the dynamic range of the A/D converter 10 is determined by reference to the signal level of the horizontal blanking period T_H , the dynamic range of the video signal cannot be appropriately adjusted.

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SUMMARY OF THE INVENTION

According to one aspect of the present invention, there is provided an automatic gain control circuit which receives a video signal including a black level which indicates a minimum brightness of a video image and a white level which indicates a maximum brightness of the video image, the automatic gain control circuit comprising a black level detecting unit which detects the black level from the video signal, a white level detecting unit which detects the white level from the video signal, and an analog-to-digital converter which adjusts a dynamic range of the video signal based on a difference value between the black level and the white level, wherein a signal level of the video signal is automatically adjusted.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiment of the present invention will be described in detail by reference to the following figures, wherein:

FIG. 1 is a block diagram showing a structure of an automatic gain control circuit in a preferred embodiment of the present invention;

FIG. 2 is a diagram showing a video signal for adjustment in a preferred embodiment of the present invention;

FIG. 3 is a diagram showing a structure of a video signal;

FIG. 4 is a diagram showing a structure of a video signal;

FIG. 5 is a block diagram showing a structure of an automatic gain control circuit in the related art;

FIG. 6A is a diagram for explaining an automatic gain control process of the related art; and

FIG. 6B is a diagram for explaining an automatic gain control process of the related art.

DESCRIPTION OF THE PREFERRED
EMBODIMENT

As shown in FIG. 1, an automatic gain control circuit 200 of a preferred embodiment of the present invention comprises an analog-to-digital converter (A/D converter) 20, a register 22, a front end block 24, and a calibration unit 26.

Adjustment of the automatic gain control of the video signal by the automatic gain control circuit 200 is executed during the initial adjustment process performed after the manufacturing process of the video signal processing device. In the initial adjustment process, a set signal is input from the outside to the register 22 and the calibration unit 26 so that the register 22 and the calibration unit 26 are set to an active state.

The A/D converter 20 receives an analog video signal from the outside, converts the analog video signal into a digital signal, and outputs the converted signal. The A/D converter 20 sets a reference voltage for the digital conversion according to a value stored in the register 22, and adjusts the dynamic range of the video signal converted to a digital signal by matching the black level of the video signal to the reference voltage during digital conversion of the video signal.

The front end block 24 receives the video signal converted into the digital signal by the A/D converter 20, and applies a pre-process for the video signal. The pre-process includes processes such as, for example, filtering and Γ correction.

The calibration unit 26 comprises a synchronization signal detecting unit 30, a black level detecting unit 32, a white level detecting unit 34, a level calculating unit 36, a target level setting unit 38, a subtractor 40, a correction value calculating unit 42, an adder 44, a gain calculating unit 46, and a pulse width modulation unit (PWM unit) 48.

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The synchronization signal detecting unit **30** receives the video signal from the A/D converter **20**, detects the horizontal blanking period T_H , and outputs the horizontal synchronization signal Hsync at the detected timing to the black level detecting unit **32** and the white level detecting unit **34**.

The black level detecting unit **32** receives the video signal from the A/D converter **20**, detects a black level which indicates a minimum brightness in the video signal, and outputs as a black level signal to the level calculating unit **36**. During adjustment of the dynamic range, a video signal for adjustment is input. As shown in FIG. 2, the video signal for adjustment indicates a minimum brightness S_{min} and a maximum brightness S_{max} in the video signal at timings which are predetermined periods $T1$ and $T2$ after the horizontal blanking period T_H . The black level detecting unit **32** receives the horizontal synchronization signal Hsync from the synchronization signal detecting unit **30**, extracts the black level (minimum brightness S_{min}) from the video signal at a timing which is the time period $T1$ after the timing of reception of the horizontal synchronization signal Hsync, and outputs a black level signal to the level calculating unit **36**.

The white level detecting unit **34** receives the video signal from the A/D converter **20**, detects a white level which indicates the maximum brightness in the video signal, and outputs a white level signal to the level calculating unit **36**. The white level detecting unit **34** receives the horizontal synchronization signal Hsync from the synchronization signal detecting unit **30**, extracts the white level (maximum brightness S_{max}) from the video signal at a timing which is the time period $T2$ after the timing of reception of the horizontal synchronization signal Hsync, and outputs the white level signal to the level calculating unit **36**.

The level calculating unit **36** detects a difference between the black level signal which is input from the black level detecting unit **32** and the white level signal which is input from the white level detecting unit **34**, and outputs the difference to the subtractor **40**. The difference value indicates a difference value between the maximum brightness S_{max} and the minimum brightness S_{min} of the video signal for adjustment; that is, a dynamic range of the video signal which is currently being output from the A/D converter **20**.

The subtractor **40** calculates a difference between the difference value which is output from the level calculating unit **36** and a target value of the dynamic range which is set in the target level setting unit **38**, and outputs the difference to the correction value calculating unit **42**. In the target level setting unit **38**, a target value of the dynamic range required as the video signal to be output from the A/D converter **20** is set in advance. In other words, a difference between the dynamic range of the video signal which is currently being output from the A/D converter **20** and a target value of the dynamic range is input to the correction value calculating unit **42**.

The correction value calculating unit **42** receives the output of the subtractor **40**, calculates a correction value of the gain corresponding to a difference between the dynamic range of the video signal which is output from the A/D converter **20** and the target value of the dynamic range, and outputs the correction value to the adder **44**. The adder **44** calculates a sum of the correction value from the correction value calculating unit **42** and the output of the gain calculating unit **46**, and outputs the sum to the gain calculating unit **46**. The gain calculating unit **46** determines a new gain value based on the output from the adder **44** and outputs the new gain value to the PWM unit **48**. In this manner, in the correction value calculating unit **42**, the adder **44**, and the gain calculating unit **46**, there is determined a new gain value corresponding to the difference between the dynamic range of the video signal which is output from the A/D converter **20** and the target value of the dynamic range.

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The pulse width modulation unit **48** receives the gain value from the gain calculating unit **46**, generates a pulse signal having a pulse width corresponding to the gain value, and outputs the pulse signal to the register **22**. For example, the pulse width modulation unit **48** generates a pulse signal having a pulse width which is proportional to the gain value. The register **22** stores and maintains the pulse width of the pulse signal, and outputs the pulse width to the A/D converter **20**.

In this manner, a new gain value corresponding to the difference between the dynamic range of the video signal which is output from the A/D converter **20** and the target value of the dynamic range is fed back to the A/D converter **20**, so that the dynamic range during digitization of the video signal gradually reaches the target value.

At the completion of the initial adjustment process, the supply of the set signal from the outside to the register **22** and the calibration unit **26** is stopped, and the register **22** and the calibration unit **26** are set in a non-active state. With this process, the pulse width of the pulse signal corresponding to the gain value which is adjusted in the initial adjustment process is stored and maintained in the register **22**, and, after completion of the initial adjustment process, the analog-to-digital conversion by the A/D converter **20** is executed in an ideal dynamic range.

As described, according to the preferred embodiment of the present invention, the dynamic range of the A/D converter can be appropriately adjusted regardless of the level of the horizontal blanking period T_H of the video signal.

What is claimed is:

1. An automatic gain control circuit for receiving a video signal including a black level which indicates a minimum brightness of a video image and a white level which indicates a maximum brightness of the video image more than one time within one horizontal period and automatically adjusting a signal of the video signal, the automatic gain control circuit comprising:

- a black level detecting unit which detects the black level from the video signal;
- a white level detecting unit which detects the white level from the video signal; and
- an analog-to-digital converter which adjusts a dynamic range of the video signal based on a difference value between the black level and the white level;
- a level calculating unit which calculates a difference between the black level detected by the black level detecting unit and the white level detected by the white level detecting unit;
- a subtractor which calculates a difference between the difference calculated by the level calculating unit and a target value of the dynamic range of the video signal; and
- a gain determining unit which determines a target gain based on the difference calculated by the subtractor, wherein the analog-to-digital converter adjusts the dynamic range of the video signal based on the target gain determined by the gain determining unit.

2. The automatic gain control circuit according to claim 1, further comprising:

- a pulse width modulation circuit which generates a pulse signal having a pulse width corresponding to the target gain determined by the gain determining unit, wherein the analog-to-digital converter adjusts the dynamic range of the video signal based on the pulse width of the pulse signal generated by the pulse width modulation circuit.